in army transports, 80 vehicles would be needed for the 250 tons considered, with 480 horses for one stage, or 960 horses for the two stages of the route. As to the personnel, the least number allowed requires one chief of the whole train, one officer or adjutant for each section of twenty vehicles, and four men per vehicle, making 325 men in all. As to the length of the train, allowing 60 feet to each vehicle, including the distance to the next, the line of vehicles will cover 4,800 feet of road. To feed the horses (counting 35 cents per day in France) will require an expenditure of $336, not counting the extra horses which always accompany a train of this kind. In the case of steam traction, 4 tons of useful load may be carried on the back part of the machine, and it will draw two vehicles loaded with 3 tons each, making 10 tons per train; thus to carry the 250 tons would require twenty-five similar trains, this being well within the limit, as the machine will take 12 to 14 tons. As to the personnel, each train requires one engineer, one fireman, and two men, and for the ensemble are needed one chief of expedition, two foremen mechanics and twenty men under them, making 150 men in all. The length of each train is about 90 feet, spacing them 30 feet apart, making a total of 2,250 feet. Each tractor consumes, for the 36 miles, $6 in combustible, etc., making the cost of transportation $150 for the whole. By comparing these figures with those for animal traction, there results an economy in personnel of 275 men, in length of train 2,550 feet, and in cost, $186. The advantage is thus decidedly in favor of steam traction. The Versailles commission conclude their report as follows: "This system may render great service in army transports of all kinds. In time of peace it reduces the expenses of haulage between military establishments and docks which are outside of the railroad system. In case of mobilization, when horses will be wanting, owing to the substitution of mechanical for horse traction in all the large cities, the tractors will be valuable for the various army transports."

MODERN SOFT-COAL MINING AND HANDLING IN THE UNITED STATES.

BY HENRY HALE.

Although the total shipments of soft coal in cargoes from the United States to foreign ports during the present year will probably not exceed six per cent of the total bituminous output in this country, the increase in export trade has attracted much attention, since the shipment is fully four times as great as that of 1898. It is calculated that the total soft coal production of the United States for 1900 will range between 170,000,000 and 175,000,000 tons.

The success of American coal exporters has been due to the prices which they have quoted, being less than those of European dealers. Several causes have contributed to the success of American competition, one of which has been the labor difficulties in Great Britain and on the Continent, which have largely curtailed the production. It is generally admitted, however, that the principal reason is the economical methods of mining and shipping the product, and the extent and richness of the American deposits. While the mines in Great Britain and Germany, for example, have been worked for centuries, many deposits in the United States have been opened but a few years. One of the principal items of expense abroad is in the construction of shafts and the elevation of the coal to the surface. Pits which extend vertically 1,000 feet to the mine workings are quite common in Lancashire, Staffordshire, and South Wales. As the beds of fuel have been worked out, shafts have been driven in some cases to a depth of nearly 2,000 feet. The construction of the shafts requires a large amount of timber to prevent caving in and the installation of power plants, operated principally by steam, for raising and lowering the men and material. The system of ventilation in such mines is also very expensive, owing to the distance which air must be conveyed. In many of the principal mining districts methods used are costly and antiquated, compared with the system in this country, a larger number of men and boys being employed, in proportion to the tonnage mined, than in the United States. The writer can state from personal observation that the coal from a few British collieries is still being brought to the surface by hoisting machinery operated by animal power. The size of the cars used upon the railways from the mines to the seaboard, and even of the mine cars themselves, is much smaller in proportion than in the United States, and the locomotives employed have less power; consequently more trains must be made up to transport a certain tonnage, at an increased cost for train crews and other service. The methods of transferring coal from the mines to the cars, and again at the shipping docks, or at the points of consumption, require more manual labor than in this country. As yet, mining by machinery is in its infancy in Great Britain, the majority of the work being done with the pick and hand-drill; consequently the number of miners in proportion to the output is far greater than on this side of the Atlantic.

The methods of procuring soft coal utilize, to a great extent, electricity and compressed air. A power station is built at a suitable point, to generate the electric current for operating the mining machines proper, driving the ventilating fans, furnishing current for the trolley mine locomotives, and supplying light in the various galleries and rooms. As fast as a mine is opened, tracks for the cars are laid in connection with the trolley system, and incandescent lamps placed in the "chambers," thus avoiding the danger of fire by other means of illumination. Many of the companies build houses for their employes, supplying them with light, baths, and other conveniences from the power station, and installing a system of waterworks and sewerage. Usually the power house and dwellings are constructed before mining proper begins. Then the main tunnel or entry is excavated to the face of the coal, its size and direction already being located by the company's engineers. The tunnel is large enough for a double-track railway and terminates in another tunnel or gallery, which extends parallel with the face of the coal seam. From it are cut short passages which terminate in the mining "chambers" or "rooms." These passages are, of course, cut through the coal and are what are termed "double entries," consisting of two passages separated by a partition of the mineral.

If the mining is done by hand, special drills are used, one miner and helper taking a contract to remove the contents of a room from 20 to 25 feet in width and about 20 feet in length.

In machine mining two miners will take a contract to clear out three chambers. The machines, operated by pneumatic or electric power, are carried to the face of the vein, and the framework is fastened in position by being screwed against the roof and sides. The electric current is conveyed to the motor operating each electric machine through an insulated cable which is connected with the main power station. This cable works upon a reel, and can be lengthened or shortened as required. If compressed air is used, it is conveyed in the same manner through flexible piping. The principal mining machines consist of steel punchers or bits bolted to movable metal belts or chains working upon platforms which are also movable. When the compressed air or electric current is turned on, it revolves the chain and its cutters, and at the same time holds the platform supporting the chain firmly against the vein of the coal. A horizontal groove is made of a depth and width varying according to the size of the machine. A Jeffrey cutter will make an incision 6 feet in depth and 4 feet in length within five minutes in ordinary soft coal. The groove is made as near the bottom of the room as possible, in order to cut or undermine the vein at its lowest point.

In one day what is known as a punch machine will cut from 175 to 225 square feet. An electric machine will cut from 720 to 900 square feet. As the average miner and helper, working by hand, will take out with drill and pick but 4 or 5 tons in the same time, the saving effected by the machines in time and labor can be appreciated. It is estimated that the saving to a mining company ranges from 20 to 50 cents per ton, according to the district where the mine is located.

From the time the mine cars are loaded until the coal is in the vessel's hold, a variety of labor-saving appliances is used. The cars, which are run to the entrance of each room, are made up into trains or "trips" which carry as high as 200 tons. One locomotive will do the work of from 15 to 40 horses or mules, according to the power of the motor. It hauls the cars from the entrance of the mine to the tipple, if there is no incline by which the force of gravity can be used. To handle a train of 20 or 30 cars, only a motorman and a brakeman are required. The locomotives vary in power, being built to work on grades as steep as 4 per cent. As they range in weight from 10 to 20 tons, the rails required for the tram road are very light.

At the tipple the weighing, separating and loading of the cars or boats are done automatically. The tipple, which is merely a wooden trestle containing a movable platform and scales, is usually located directly above the railroad track, or at such an incline that the coal will fall into the cars by the force of gravity. A car is elevated at the tipple so that by opening one end the contents run out upon the separation screens and scales, which record the total tonnage. From the scales the coal according to its size falls into the cars, which are usually made up in trains. As fast as a car is filled the locomotive pulls the next empty car below the tipple, and thus the operation is continued until the train is loaded. If it is desired to separate the coal into the three commercial sizes, three tracks are laid below the tipple, and three trains can be loaded at once. In connection with a number of the mines in West Virginia and in the George's Creek and Cumberland region of Maryland, as well as in Alabama, are coke-oven plants, so constructed that the mine cars can be run from the entrance directly over the ovens, and their contents dumped through openings made especially for the purpose, without the necessity of any manual labor except to guide the cars.

The cost of coal mining by the modern process has been reduced to such a figure that the product has been sold at the tipple as low as 90 cents per ton, at a small profit to the coal company. The actual cost of the coal placed on the cars ready for shipment has been reduced as low as 75 cents per ton in the districts referred to. Of course, these figures are subject to slight fluctuations, but it is calculated that 90 cents per ton is the maximum cost of this production. Including the railroad and steamship tariff and the cost of transferring at the destination, American coal has been placed in French ports, for example, at $5.50 per ton at a profit to the shipper. But it is believed that steamships can be built especially for the coal trade which can carry a cargo to Mediterranean ports at less than $1 per ton freight, including wages, food for the crew, fuel and charges of every kind. This figure would enable coal of a superior quality to be sold abroad at less than $3 per ton, fully $2 less than the best Welsh product.

Electrical Notes.

It is stated that the Jungfrau Railway in its entirety is to be abandoned, but the section already built and under construction will undoubtedly be very popular.

All the Russian warships on the Chinese station are to be fitted with Popoff's system of wireless telegraphy. The experiments with this apparatus have been carried out up to distances of forty miles with perfect success.

The premises at 5 West Twenty-second Street, New York city, which were formerly occupied by Prof. S. F. B. Morse, were torn down for the erection of a business building. It is gratifying to note that Mr. McCutcheon has had the tablet which used to mark the house replaced. The addition to the original bronze reads, "This tablet removed from building formerly on this site and replaced A. D. 1900."

A suburban electric street car line in St. Louis has fitted one of its cars with a telephone, says The Railway Review. The instrument is placed in the rear of the car, the negative wire being connected permanently through the wheels to the rail, and the positive wire being fitted with a simple device resembling a jointed fishing pole by which connection is secured to a private overhead wire paralleling the trolley.

The second branch of the Metropolitan Underground Road at Paris was opened on September 29. It runs from the Triumphal Arch to the Trocadero. Another line running north and south will be opened next spring. The American engineers have been impressed with the rapidity with which the work is carried on, only sixteen months having elapsed in building the tunnel from Vincennes to the Bois de Boulogne.

Ever since telephonic communication has been established between London and Paris, it has been constantly rumored that attempts were being made by the English and Belgian governments to inaugurate a similar service between London and Brussels. It is announced that in February, Brussels will be connected with the English capital by the telephone. There have been several obstacles in the way which have prevented realization of this scheme. Great difficulty was encountered in obtaining the sanction of the two governments, but after prolonged negotiations the necessary permission was obtained. The electricians of the English Post Office had two alternative schemes. One was to lay a cable from the English to the Belgian coast; and the other was to utilize the Anglo-French wire as far as Calais, and then to extend to Brussels over wires on land. According to present arrangements it appears that the latter plan is to be adopted, since it has been found impossible with existing instruments to transmit vocal communication through a submarine cable over a greater distance than twenty miles. This is the length of the cable in connection with the London to Paris telephone, and also the cable connecting England with Ireland.

Large refuse destructor and electricity generating works are to be constructed by the vestry of Hackney, a northeastern suburb of London. Five acres of land have been acquired on the banks of the River Lea upon which to erect the buildings. The present designs are sufficient to accommodate 6,000 horse power in boilers, engines, dynamos and switchgear, but the first installation of machinery will only amount to 3,000 horse power which will be sufficient with accumulators to provide a current for 50,000 eight-candle power lamps. The engines will be of the triple-expansion type, with a working pressure of 175 pounds per square inch. Two dynamos will be driven direct by each engine, and a common condenser and cooling apparatus will be supplied to each pair of engines. The refuse destructor will comprise twelve furnaces with a daily burning capacity of 150 tons. It is estimated that the total cost of the scheme will amount to $1,250,000, but it is anticipated that the vestry authorities will effect an economy of $20,000 per annum. According to the Act of Parliament, the vestry are enabled to levy a maximum tariff of 16 cents per unit, but they propose to encourage the more general utilization of electricity by charging 8 cents to private consumers; 6 cents for public lighting; and 4 cents for the supply of electric power.

Science Notes.

An expedition has been sent to Kingston, Jamaica, by Harvard Observatory to observe the planet Eros in its approaching opposition.

Dr. A. Donaldson Smith, the African explorer, has arrived in this country and will deliver lectures. Mr. Edward Whymper has also reached the United States, and has given some lectures.

The Pekin Observatory, which for two centuries has been one of the chief glories of Pekin, has been looted, and half the instruments will go to Berlin, and half to Paris. The instruments were erected by the Jesuits.

Prof. Schiaparelli retired on November 1 from the directorship of the observatory at Milan, where he had been at work for the last forty years. He has been one of the most conspicuous figures in Italian science. His successor is Prof. Celoria.

The Dewey Arch, a temporary structure built to do honor to the victorious admiral on his return, is being removed. For more than a year it has stood in Madison Square without becoming dangerous to passers-by. This speaks well for staff construction.

The four hundredth anniversary of the birth of Benvenuto Cellini will be celebrated in Florence by a festival and by setting up the sculptor's bust on the Porto Vecchio. Invitations have been sent out to goldsmiths' associations all over the world.

A committee of scientific men who were appointed to investigate the matter state that an eruption of Mt. Vesuvius may be expected at any time. It has been some time since there has been a dangerous outbreak. The experts in the observatory say that an eruption may occur at almost any time, but they are not ready to predict the strength of the eruption.

More time, endeavor and money have undoubtedly been put into the Zeppelin airship than into any previous enterprise of this nature. It is thirty years since Count Zeppelin first turned his attention to the airship as an engine of war, and those who were making experiments in flight by means of aeroplanes were inclined to look upon him as a visionary.

The Tiber at Rome has become swollen by heavy rains, and the water in the Forum was six feet deep on December 2. The Protestant cemetery is inundated, and it is impossible to get within 2,000 feet of St. Paul's Without the Walls. A large landslide occurred on the bank, and the arches of two bridges have disappeared. The dwellers in the lower sections of the city are in great distress.

In excavating for the drainage system which is being installed in the city of Mexico, a number of articles were found which belonged to a period previous to the invasion of Cortez. Some of the articles found were golden ornaments with which the Aztec gods were decorated. On the extension of the Mexican Central Railway, workmen dug out $50,000 in gold and silver coins, the government and the workmen sharing equally under the old law of treasure trove.

The new lecture hall of the American Museum of Natural History is believed to be the largest auditorium ever built for scientific lectures. It seats 1,500 persons. There are three screens, each 25 feet square, two being placed at the back of the stage, and one is movable. The lanterns are in a special room in the center of the gallery. The broad platform is provided with unusual arrangements for scientific experiments. The city has thus far paid $4,472,000 for the institution in the way of buildings, etc., and the trustees have raised more than three million dollars additional.

The authorities of the British Museum have recently secured the exhaustive collection of 20,000 moths from Western China which formed part of the collection of the late Mr. J. H. Leach, and is the finest collection of lepidoptera in the world. The Museum paid $5000 for the right to choose what they desire from the collection, which will be about 12,000 specimens. Mr. Leach had specimens of several moths not to be found in any other collection extant. Sir George Hampson, Bart., who classified the moths of India for the Indian government some years ago, will make the choice and arrange them in the present British Museum collection. The work will occupy about twelve months.

Lieut. Julius Payer, well known for his Arctic explorations, was a great admirerer of Dr. A. Petermann, the German geographer, who has given great attention to Arctic explorations. When Lieut. Payer in 1870 discovered the pyramidal mountain in Greenland, he called it Mt. Petermann, and it was long supposed that this was the highest mountain in Greenland. His last survey gave the height as 12,406 feet, but last year Dr. Nathorst discovered that the real height of the summit was between 8,200 and 9,000 feet above the sea level, so that the mountain can no longer be called the highest in Greenland. The Duke of Abruzzi in his last expedition discovered that King Oscar Land and Petermann Land, as was suspected, did not exist. It is probable that Lieut. Payer saw icebergs, which he took for land, so that in both of these cases the connection of the name of Petermann with the two localities is very unfortunate.

Report of the Secretary of Agriculture.

The annual report of the Secretary of Agriculture is a most interesting document. It is devoted to a brief résumé of the important work carried on by the various Divisions. Important extensions of the Weather Bureau work have been made during the past year. Its efforts have been specially directed to the investigation of methods of electrical communication without wires, with a view to establishing wireless electrical communication between vessels at sea and exposed points on our lake and sea coasts. Already messages have been successfully transmitted and received over sixty miles of land, and the Secretary expresses the hope that in the near future the craft employed in our coastwise commerce and on the Great Lakes will be placed in instantaneous communication with the stations of the Weather Bureau located at the principal ports. Special storm forecasts for the North Atlantic will be undertaken shortly through the use of reports received from the West Indies, Bahamas, Bermudas, the Azores, and Portugal, the new cable system connecting Lisbon with America, via the Azores, making this possible. Much stress is laid upon the continued improvement of the forecast service, and the value of its warnings. Mr. Wilson points out that notwithstanding the great number of craft plying the Gulf of Mexico at the time of the Galveston storm, the warnings were so timely that there was no disaster upon the open waters.

The Bureau of Animal Industry has carried on its highly important work, and the total number of cattle inspected before killing aggregated 53,087,994, in addition to an inspection of 34,737,613 animals which had been killed. The total number of carcasses condemned was 61,906, and the number of live animals rejected was about 160,000; 999,554 microscopic examinations of pork were made. During the season of 1899, over a million cattle were moved, under the supervision of the Bureau, from the districts infected with the southern cattle tick. Over 1,800,000 sheep were inspected, and nearly 627,000 dipped under the supervision of the inspectors. The work of preparing serum for various diseases has also been carried on. With regard to rabies the Secretary declares that this disease is unfortunately on the increase in the United States.

The Division of Chemistry has carried on important work in the investigation of food adulteration; over 500 samples of preserved meats of all kinds were purchased in the open market, and examined. The Division finds that very little horse meat is sold in the United States. The foreign food products introduced into this country have been the subject of careful study.

Most satisfactory reports are received from California as a result of the entomological work in the introduction of the insect which fertilizes the Smyrna fig. In one locality more than six tons of Smyrna figs have been produced; this result will tend to make America a great competitor in the fig trade of the world's markets. An important parasite has been introduced to prey upon the olive scale, so injurious to the olive growers of California. From Natal a fungus disease has been introduced by which the injurious worms and locusts have been destroyed, and efforts are being made to introduce European parasites of the gypsy moth.

The results of seed testing are declared to be satisfactory, and to have greatly improved the quality of seed distributed by Congress. Experts of the Division have been studying plants poisonous to stock in Montana, and valuable experiments will be conducted on the ground set aside for the use of the Department on the Potomac flats at Washington. The section of seed and Plant Introduction receives a special notice, stress being laid particularly upon the importation of cereals, including macaroni wheats of southern Europe and grasses and forage plants. The Kiushu rice introduced from Japan has already added one million bushels annually to the Louisiana rice crop. The introduction of date trees into Arizona is another valuable achievement. The introduction of wheats from Russia, Hungary, and Austria is being watched with great interest, and if the wheat yield of the United States should be increased by only one bushel per acre, this would mean at the farm price of wheat in 1899 an addition of $26,000,000 to the income of our farmers. The Division of Vegetable Physiology and Pathology has also been carrying on important investigations. In plant breeding, orange hybrids have been placed at various points in the South and their value has been tested in cooperation with several experiment stations. In corn breeding the features aimed at are early maturity, drought and smut resistance, increased protein content and a large yield. Diseases of sugar beet have been investigated, also diseases of forest trees.

The Division of Pomology made a most interesting exhibit at the Paris Exposition, which attracted wide attention. A special effort has been made to give a thorough test to the cultivation of choice European grapes in the South Atlantic States. The work of the Division of Agrostology has been thoroughly systematized. The grass garden on the Department grounds contains nearly 500 varieties. The destruction of prairie dogs has become a practical question of interest to farmers, and is being investigated by the Biological Survey. Warning is given of the possible danger of the introduction and dissemination of the Belgian hare. Laboratory work and the study of food of birds of economic importance have received attention. The work of the Soil Survey has been greatly increased, but still falls short of meeting the demand for soil surveying from all sections of the country. The work of this division with tobacco is specially noticeable. The tobacco exhibit at the Paris Exposition was one of the largest as well as one of the most complete made, containing over 2,000 samples. Florida-grown Sumatra tobacco was awarded twenty points of merit against eighteen points for real Sumatra leaf, and the yellow tobacco of North Carolina was awarded as many points as the Turkish tobacco with which it competed.

The relations of the Division of Forestry with practical lumbermen and tree planters have been closer and more useful than ever before. The total requests for working plans for scientific forestry exceeded fifty million acres. The Department is receiving with increased frequency applications for planting and working plans for watersheds from which cities obtain their supplies. There is much inquiry in all sections of the United States regarding better roads and better methods of building them. Much work has been done by the Office of Road Inquiry and in co-operating with colleges and stations.

The Secretary reviews at considerable length the work of the experiment stations first established in this country twenty-five years ago. The stations now employ nearly 700 persons, and in 1899 their publications aggregated 445 reports and bulletins. The study of foreign markets abroad with special reference to extending the trade therein for the agricultural products of the United States has been prosecuted with zeal and intelligence. The agricultural exports of the United States for the past fiscal year amounted to $844,000,000. The rapid growth of our export trade to the Orient in recent years is most striking. In 1900 our export trade to the Orient amounted to $107,000,000. The Division of Statistics and the Division of Publications both carried on their labors with the usual satisfactory results. The annual output of publications was 7,000,000. Notwithstanding the enormous amount of work which the Department carries on, the appropriations for the fiscal year amounted to only $3,006,022. In addition, the sum of $720,000 was provided for division among the agricultural stations at the Paris Exposition; American exhibitors in agriculture, horticulture, and food products received about 500 awards.

A New Metal-Etching Process.

A new process of etching metal by an acid blast has been introduced. An atomized spray of acid is projected vertically against the metal surface which is to be etched by means of an air blast, the pressure being from 5 to 8 pounds. The compressed air passes from the air tank to the atomizer and to the washing apparatus. Each atomizer consists of a central tube supplied with air under pressure, and surrounded by smaller tubes in connection with the acid in the tank. By this arrangement the air blast produces a finely divided spray of acid, which is projected with considerable force against the metal surface required to be etched. The surplus acid falls back to the lower part of the tank and is again drawn into the atomizer, so that the liquid is constantly circulated during the progress of the operation. Means are provided for moving the plate during the etching operation, to intensify the action of the acid. After the etching is concluded, the plate is washed with the aid of water under pressure. According to Feilden's Magazine, erosion under the acid blast is very rapid. Some zinc plates treated with nitric acid diluted to 10 degrees Bäume were etched in three minutes as deeply as the "second etch" of the immersion process, which will probably occupy about twenty minutes. It is not practical to force the speed of erosion in the ordinary process, as details would be eaten away by undercutting, and the heat would tend to melt the resist. In the case of the acid-blast process the projection of the spray upon the surface in a perpendicular direction insures proper etching without undercutting the protected parts of the metal. Overheating is also successfully avoided, as the compressed air is thoroughly cooled before it enters the aspirators, and the amount absorbed during expansion is fully equal to that due to chemical action between the acid and the metal.

An Invention Probably Lost.

John G. Carter, the inventor of the process of making a substitute for rubber from cotton-seed oil, died recently at Savannah, Ga. The process was known only to Mr. Carter, and unless it is found that he left instructions and directions for the continuance of the work, it is probable that the secret died with him. This is a valuable illustration of the wisdom of patenting all inventions of any commercial value, and not leaving the matter a secret. Very valuable inventions have been lost to the world, owing to a mistaken belief that our patent laws do not give adequate protection.